An Initial Biomedical Physics Elements-of-Competence Inventory for First Cycle Physiotherapy Programmes in Europe

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1 Introduction

This paper presents an initial version of a biomedical physics elements-of-competence inventory for First Cycle Physiotherapy programmes in Europe and describes the process used in its development. The research reported forms part of an ongoing project the purpose of which is to put the role of the biomedical physics educator within Faculties of Medicine / Health Science on a firm foundation. The results of this research has indicated that a strategic mission statement for the role would be that: *"Biomedical physics educators will make a decisive contribution to quality healthcare professional education through the pursuit of practice-oriented curriculum research, development and delivery in the physics-engineering competences necessary for the scientific, effective, safe, ethical and efficient use of biomedical devices and the supervision of student research involving such devices"* Biomedical devices are strongly underpinned by physics principles. They are crucial to modern healthcare and the subject of several EU directives, hence offering an excellent opportunity for role consolidation. In this context 'effective' means ensuring that the intended healthcare purpose for which the medical device is being utilized is achieved. 'Safe' refers to the avoidance of unnecessary risk to patients and the total elimination or reduction to acceptable levels of risks to users and others from physical agents associated with devices. 'Physical agents' refers to ionizing radiation, mechanical, electrical, acoustic, ultrasonic, magnetic, electromagnetic, high temperature, optical, ultraviolet, infrared, and laser risk sources. 'Efficient' refers to achievement of purpose with minimum device use time. A generic curriculum development model which can be used to drive curriculum development for the healthcare professions was derived from the above mission statement. The model has already been used for the construction of elements-of-competence inventories for Diagnostic Radiography, Medicine and Nursing [1-3]. This paper presents a similar inventory for physiotherapists (alternative professional titles in Europe are 'physical therapist' and 'kinesitherapeute'). Only one paper has been found in the literature which involves the teaching of physics in the physiotherapy context. It addresses teaching methodology and assessment [4]. This paper focuses on *content*.

2 Research Design

The conceptual framework guiding the study was competence-based curriculum development, the research technique document analysis. The document "European Physiotherapy Benchmark Statement" [5] which lists the competences expected of newly qualified physiotherapists in Europe (physiotherapy is not yet participating in the Tuning project of the Bologna process in Europe) was scrutinized and the subset of physiotherapy competences that included major biomedical device aspects singled out. The physiotherapy competences were then carefully deconstructed into elements-of-competence and those elements falling within the biomedical physics learning domain inventorized. To ensure a comprehensive approach we also surveyed European physiotherapy undergraduate curricula, EU legislation and documentation, national physiotherapy standards of proficiency, educational benchmark statements from higher education quality assurance agencies and research articles relevant to standards of physiotherapy practice, role development and undergraduate physiotherapy education.

3 Results

An analysis of the European Physiotherapy Benchmark Statement in the light of the above mission statement indicated that the aim of physics teaching within physiotherapy education would be to ensure that learners acquire the necessary physics elements-of-competence underpinning the following broad Physiotherapy Competences:

1. An understanding of the biological, physical and behavioural sciences which underpin physiotherapy and the ability to use this knowledge and understanding appropriately in a variety of practice contexts.
2. An ability to apply appropriate physiotherapy assessment (biomechanical, electrophysiological), anthropometric and ergonometric measurement techniques.
3. An ability to make effective and safe use of therapeutic modalities based on the use of electrical, thermal, light, sound and magnetic energy.
4. An understanding of the performance framework and quality assurance mechanisms within physiotherapy practice.
5. An ability to practice in accordance with current legislation applicable to healthcare professionals.
6. An ability to practice with an appropriate degree of self-protection.
7. An ability to contribute to the well-being and safety of all people in the workplace (including risk assessment).

Although medical imaging devices are not mentioned in the benchmark statement and although physiotherapists are not authorized users of such devices, present physiotherapy role developments (e.g., medical image interpretation within a practitioner role) indicate emergent learning needs in this area which would require knowledge and understanding of the physical principles underpinning these devices. Patient safety and occupational safety for all healthcare professionals are legal requirements which are still not being given due importance in healthcare professional curricula [6,7]. Learning regarding safety vis-à-vis physical agents should be included as it is required by several EU directives. The suggested biomedical physics elements-of-competence inventory for physiotherapy is shown in Table 1. The inventory would guide educators in preparing students for use of the devices they would be meeting in their undergraduate practice and also lay the foundations for the learning of those devices that they would need to use after their graduation in both their professional practice and in research. We intentionally avoided making the inventory too prescriptive. This prevents educator and student disempowerment with respect to content, allows for diversity, and permits the development of native solutions to local curricular targets.

Table 1. Biomedical Physics Elements-of-Competence for Undergraduate Physiotherapy in Europe

Inventory of Biomedical Physics Elements-of-Competence for Undergraduate Physiotherapy in Europe
Define a medical device as described in the Medical Device Directives
Appreciate the range and importance of biomedical devices used in the clinical and research contexts.
Demonstrate awareness of the importance of a risk assessment (patient, occupational, public risk) with respect to physical agents before utilization of a device. Physical agents include ionizing radiation, mechanical, electrical, acoustic, ultrasonic, magnetic, electromagnetic, high temperatures, optical, ultraviolet, infrared, laser. EU medical device risk classes.
Explain the general structure of a biomedical instrument (including range of biomedical sensors, signal processing modules, output devices, basic *qualitative* frequency analysis, signal digitization, bit-depth). Utilize measurement concepts (e.g., accuracy, noise, uncertainty, precision, calibration) and data processing (use of formulas for uncertainty in the mean of a set of data, linear regression and correlation coefficients) in the collection and analysis of data from physiological and biomedical laboratory measurement devices. Explain ways of reducing risk when using such measurement devices.
Explain anatomical and physiological imaging devices in terms of measurement of the spatial distributions of physical and physiological properties of body tissues and their pictorial representation. Safety issues in biomedical imaging.
Understand the various forms of microscopy and the advantages and disadvantages of each.
Apply basic image processing (e.g., zooming, magnification, windowing, smoothing and sharpening filters) for increasing the diagnostic effectiveness of images.
Understand at a basic level appropriate to non-users the physical principles underpinning biomedical devices to be found in the following device groups: intensive and critical care devices, renal devices, surgical and pre-surgical (e.g., endoscopic) devices, prosthetic devices and biomaterials, assistive devices.
Understand the concepts of device performance indicator and device limitation and their relationship to clinical effectiveness and safety criteria.
Appreciate the importance of following user protocols to ensure performance indicators are not impacted negatively, to reduce effects of limitations of the device and to eliminate or reduce risk to all concerned.
Demonstrate awareness that a device needs to be quality controlled for ongoing effective and safe use. In particular, a device needs to be checked before use (daily QC), cared for during use and left in a condition for subsequent use by self or others.
Understand how to get maximum benefit from reading the user manual of a device.
Explain ethical issues in the use of devices (e.g., qualitative risk-benefit analysis, equitable use of resources, the importance of the economical use of devices, the obligation to optimize benefit and minimize risk).
Explain EU Directives regarding medical devices and patient and user safety.
Appreciate the variety and potential far-reaching effects on clinical medicine of emerging device technologies (e.g., telemetry, automation, robotics, point-of-care (POC) devices, micro and nano-devices, molecular imaging, virtual reality systems).
Apply the above competences to the effective, safe, ethical and efficient use of the following therapeutic devices: infra-red irradiators, short-wave and micro-wave diathermy devices, low intensity laser, UV phototherapy devices, ultrasound therapy devices, low frequency current therapeutic devices (e.g. TENS); and also the following diagnostic devices: electrophysiological testing devices, high frequency US / Doppler wound assessment devices
Appreciate the need for patient radiation protection as required by the role of prescriber.
Demonstrate a scientific attitude in the use of devices in biomedical research.

Note: Please address feedback regarding the above inventory to Carmel J. Caruana (carmel.j.caruana@um.edu.mt). Suggestions adopted will be acknowledged in future versions of the inventory.

4 Conclusion

The deconstruction of broad healthcare professional competences which involve the use of biomedical devices into elements-of-competence and the construction of structured biomedical-physics-based elements-of-competence inventories as outlined in this article are essential in the systematic development of the physics component of competence-based healthcare professional curricula. An important use of such inventories is that of a checklist to ensure that all essential physics elements-of-competence embedded within broad healthcare professional competences are included in the curriculum and that all are eventually assessed.

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